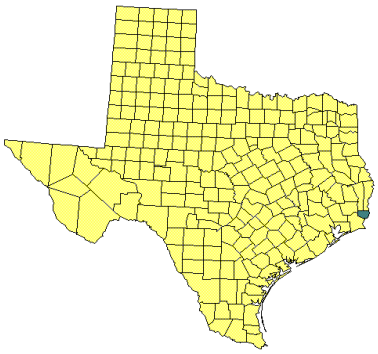
Post Waterflood CO2 Miscible Flood in Light Oil Fluvial-Dominated Deltaic Reservoirs -- Class I

Texaco E&P



Frio Formation
@ 5,900 ft.
Oligocene Age

Port Neches Field
Orange County, TX
East Texas Basin

DE-FC22-93BC14960

Contract Period:
6/1/1993 to 12/31/1997

DOE Project Manager:
Gary D.Walker
918/ 699-2083
gwalker@npto.doe.gov

Contractor:
Texaco E&P
400 Poydrass Street
New Orleans, LA 70130

Principal Investigator:
Tim Tipton
Texaco E&P
400 Poydrass Street
New Orleans, LA 70130
504/ 680-1728
504/ 680-6577

Objective: This project will use a combination of a CO2 miscible flood and horizontal gas injection to increase production in a watered-out salt dome reservoir. The site of the proposed project is the Port Neches Field in southeastern Texas. The process will be compared in two adjacent fault-block reservoirs, one producing under partial water drive conditions and the other post-waterflood.

Technologies Used: Core Analysis: Sidewall and conventional. Fluid Analysis: PVT analysis of recombined fluids. Log Analysis: Porosity to permeability transforms. Well tests: Production tests; radioactive tracer test. Seismic: 3-D seismic. Reservoir modeling: 3-D model incorporating porosity-permeability data, layering, and honoring seismic and biased model based on knowledge of depositional model. Recompletion: Workover existing wells. Horizontal drilling: Drilled horizontal CO2 injection well injecting at O/W contact. CO2 injection: CO2 WAG injection; CO2 huff-'n'-puff treatments.

Background: This project involves CO2 flooding of pressure-depleted Marginulina sands in the Port Neches field. Production was discovered in 1929. Two fault blocks are involved in this project with the strength of water drive varying between fault blocks. In the larger fault block, reservoir pressure had declined 2,700 psi to 100 psi when waterflooding was started in 1965. Water drive support was somewhat stronger in the smaller fault block, which had not been waterflooded. Primary production in the larger and smaller fault blocks was 40.4% and 42.9% of the OOIP, respectively. Waterflooding had recovered an additional 14.4% of the OOIP from the larger fault block. Before the project, production from the larger fault block was only 25 BOPD and 1,200 BWPD. One well in the smaller fault block produced 5 BOPD and 50 BWPD.

Incremental Production: Peak - 480 BOPD @ 10/94; 350 BOPD @ April 1995. Primary production in the larger fault block was 40.4% OOIP. Waterflooding has recovered an additional 14.4% of the OOIP.

Expected Benefits and Applications: If successful, process would be applicable to a large number of Gulf Coast reservoirs. The project plans to demonstrate the benefits of CO2 flooding in a watered-out salt dome reservoir using a horizontal CO2 huff-'n'-puff injection well. CO2 flooding in watered-out salt dome reservoir; horizontal CO2 huff-'n'-puff injection well.

Accomplishments: The project required the installation of CO2 facilities. Liquid CO2 was purchased, transported to the field via a four-inch pipeline, then injected. Initial operations focused on the larger fault. Texaco injected salt water to raise reservoir pressure, then began injecting CO2 in 1993 in vertical injection wells. The planned horizontal CO2 injection well was drilled in early 1994, but mechanical problems limited the horizontal section to only 250 ft rather than the planned 1,500 ft. To control premature CO2 breakthrough, CO2 and water are alternately being injected in the injection wells. The 3-D seismic data indicate that the smaller fault block area is too small to justify CO2 flooding, so CO2 huff-'n'-puff treatments are being used. A software model for screening candidate reservoirs was developed (streamtube screening model). Ten workovers completed, unitization approved, and reservoir pressure raised from 1850 psi to 2350 psi. Conducted an extensive 3-D compositional simulation study to model reservoir performance. Developed, in conjunction with LSU Petroleum Engineering Department, a reservoir model screening tool for the CO2 miscible process. One hundred and ninety seven light oil, waterflooded Louisiana reservoirs were screened for CO2 applicability. Developed a reliable analytical method for tertiary reserves prediction, production rates and CO2 volumes using type curves. Proved the WAG process to be an effective mobility control method in highly permeable sands. The technology has not spread to other fields.

Publications: (1) Bou-Mikael, S., "Post Waterflood CO2 Miscible Flood in Light Oil, Fluvial-Dominated Deltaic Reservoir," Annual Report to DOE for period Oct. 1, 1993-Sep 30, 1994, DOE/BD/14960-8, July 1995. (2) Bou-Mikael, S., "Post Waterflood CO2 Miscible Flood in Light Oil, Fluvial-Dominated Deltaic Reservoir," Interim Project Report to DOE for period Sept. 30, 1994-May 31, 1995, Aug. 1995. (3) Bou-Mikael, S., "A New Analytical Method to Evaluate, Predict, and Improve CO2 Flood Performance in Sandstone Reservoirs," SPE 35362, SPE/DOE Improved Oil Recovery Symposium, Tulsa, OK, April 21-24, 1996.

Recent/Upcoming Technology Transfer Events: None scheduled.

Project Status: Project completed December 1997. No final report.